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MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CORNELL UNIVERSITY

Communicated by E. B. TITCHENER and H. P. WELD

XXVIII. MECHANICAL VS. MANUAL STIMULATION IN THE DETERMINATION OF THE CUTANEOUS TWO-POINT LIMEN

By M. CARNES and L. C. SHEARER

In the determination of the limen of dual impression upon the skin, great care is necessary in order to reduce the errors incident to the application of the aesthesiometer. The two points must be set down simultaneously and with the same pressure. Their rate of application should be controlled. If they are removed before judgment is made, the time of application should be constant and their simultaneous removal assured. The control of most of these factors is usually left to the manual skill of the experimenter. In instruments of the type of Washburn's¹ or Jastrow's² aesthesiometers a constant pressure (the weight of the instrument) is secured by allowing the handle to slip loosely upon the shaft which supports the points, so that the experimenter can not decrease or increase the pressure upon the points after they have been applied. This device does not, however, insure equal pressure upon the two points; the experimenter must keep the shaft of the instrument perpendicular to the skin, or he will exert more force upon the one point than upon the other. It seems then as if a mechanical applicator, which brings the points down simultaneously, with equal pressure, and at a constant rate, should constitute a more desirable method of stimulation.³ Accordingly we arranged to put the question to the test of experiment.

The one of us (C) acted as observer, the other (S) as experimenter. With the old form of the Jastrow aesthesiometer,⁴ we twice determined the longitudinal limen for an area of the

¹ M. F. Washburn, Some Apparatus for Cutaneous Stimulation, *Amer. Jour. of Psychology*, 6, 1894, 422.

² The improved form is described by G. M. Whipple, *Manual of Mental and Physical Tests*, 1914, Pt. I, 246.

³ An editorial note in *Amer. Jour. of Psychol.*, 1, 1888, 552 f., describes a fixed form of Jastrow's aesthesiometer in which the position, but apparently not the rate of application, is kept constant. The writer cites no experimental results to demonstrate the advantages of the instrument. See also E. W. Scripture, *Thinking, Feeling, Doing*, 1895, 111.

⁴ Similar to the improved form used by Whipple, *loc. cit.*, but shorter and with pyramidal points. Its weight (without the handle) is about 27 grams, giving a pressure on each point of 13.5 grams. It is figured in the catalogue of the Garden City Model Works, Chicago, 1894. See E. B. Titchener, *Experimental Psychology*, II, ii, 1905, 160, 258.

volar surface of the left fore-arm, 5-10 cm. above the wrist; once with the usual manual application of the aesthesiometer, and once with mechanical application. We used the method of constant stimuli, taking one hundred series for each mode of stimulation. The series for mechanical and for manual stimulation we divided into groups of ten, and alternated the groups (with reversal of alteration after the first hundred and the interval of a day between the two hundred) so as to equalize practice. In order to avoid fatigue frequent rests were introduced. Not more than thirty series could be taken at a session, and frequently it was found advisable on account of fatigue to stop after twenty series. Every series consisted of five separations, and the same values (2, 8, 14, 20, and 26 mm.) proved to be suitable in each case.

The mechanical application of the stimulus was secured by means of Titchener's applicator. The handle of the aesthesiometer was fixed to the end of a hollow, vertical brass rod; the shaft passed up through the rod. The rod bore a rack upon its side, and could be lowered through a bearing by turning a crank which operated a set of gears (worm, wheel, pinion, and rack). A single revolution of the crank lowered the rod 3.25 mm. The rate of application was controlled by turning this crank in time with a soundless metronome, at the rate of one revolution per sec.; a linear speed of application of 3.25 mm. per sec. Two complete turns brought the aesthesiometer free upon the arm. The observer lay supine upon a couch beside the apparatus. His arm was extended, volar surface upward, beneath the apparatus, and was held in a plaster cast. The cast enclosed the arm on three sides and was provided at the end with a grip, moulded to the hand, which the fingers grasped. It was adjusted beneath the apparatus and fixed so that a straight line upon the skin lay horizontally and directly under the aesthesiometer. The limen was determined along this line. To prevent the fatigue of particular spots provision was made for shifting the whole stimulating apparatus a little distance along the line; the casting, which bore the gears and the bearing for the vertical rod, was arranged to slide on two horizontal rods. A long wooden screw at one side furnished a means for moving it horizontally. The experimenter turned this screw before commencing a new series, thus moving the apparatus along the arm and preventing too frequent stimulation of the same spots. After several series, the apparatus was set in its initial position and again shifted along. Since the simultaneous application of the two points was assured by the apparatus, and since the aesthesiometer could move only in a straight line, the pressures upon the two points were equal (*ca.* 13.5 g. each). We found that the arm was not perfectly rigid within the cast and that an alteration in the position of the body at successive sessions sometimes threw out the adjustment of arm to apparatus. It was always possible, however, either by moving the body or by shifting the apparatus slightly in the horizontal direction, to secure again the desired adjustment.

In the series with manual stimulation the arm was kept in the cast and the position of the observer was unaltered. The experimenter worked always with the utmost care.

The following percentages of 'two-judgments' were obtained:

Separations:	2 mm.	8 mm.	14 mm.	20 mm.	26 mm.
Manual application.. . . .	16%	37%	62%	87%	97%
Mechanical application	11%	37%	64%	84%	94%

From these percentages the limens were computed by means of Urban's tables.

Manual application:	Limen = 11.4398 mm.	$h = .0816$
Mechanical application:	Limen = 10.7894 mm.	$h = .0837$
	Difference = 0.6504 mm.	

Mechanical application gives both a lower limen and a higher value of h . The difference in favor of mechanical stimulation is not great (6%); yet it is significant. Its probable correctness (*i. e.*, the probability that the manual limen is greater than the mechanical) is 83%.⁵

Conclusion.—We conclude, then, that there is a slight scientific advantage gained by the mechanical application of the aesthesiometer. The determination of the limen is slightly more accurate, and the limen itself is slightly lower—as a result, we may assume, of the greater evenness of stimulation—than with manual application. The differences, though small, are mathematically significant. The advantage is, however, too slight to require the use of a mechanical method under the usual conditions. For all practical purposes, careful manual stimulation is adequate.

⁵ For the method of computing this probable correctness, see discussion by E. G. Boring in the present number of the JOURNAL.